

Chlorpyrifos Executive Summary for ESA Assessment

This Biological Evaluation (BE) assesses whether the registered uses of chlorpyrifos (PC code 059101), based on the U.S. Environmental Protection Agency's (EPA) proposed federal action, will result in a potential effect to an individual of an endangered and threatened (listed) species and/or designated critical habitats. The evaluation also includes analysis of impacts to candidate species as well as species and critical habitats proposed for listing for conferencing purposes under section 7 of the Endangered Species Act (ESA). This evaluation, conducted as part of the registration review process (EPA's action under consultation), is based on interim scientific methods developed in response to recommendations of the National Research Council (NRC, 2013) and uses a three-step consultation process.

Step 1 consists of two parts: 1) establishing the action area for the proposed action, and 2) overlaying the listed, proposed, and candidate species (hereafter, "listed species" ranges and proposed and final critical habitat designations (hereafter, "critical habitat(s)" onto the action area (**Section 1.4.1**). This step identifies which species and critical habitats have the potential to be affected by the proposed action. A "no effect" determination is made for species and critical habitats whose ranges do not overlap with the action area and listed species that are presumed extinct as identified in the species reports. Any listed species and/or critical habitat that warrants a "may affect" determination in Step 1 (*i.e.*, its range and/or critical habitat overlaps spatially with the action area and it is not presumed extinct) continues for further analysis in Step 2. Step 2 determines whether effects to individuals of listed species and/or Primary Constituent Elements (PCEs)/physical and biological features (PBFs) of critical habitat result in a "may affect, not likely to adversely affect (NLAA) determination, or a "may affect, likely to adversely affect" (LAA) determination. In Step 2, toxicity (indirect and direct effects data) and exposure information are analyzed using a weight-of-evidence (WoE) approach. These data are organized into lines of evidence that inform risk hypotheses and ultimately the effect determinations for listed species and their critical habitats. The NLAA determinations are submitted to the US Fish and Wildlife Service and the National Marine Fisheries Services (the Services) for concurrence, while the listed resources with a LAA determination are considered by the Services in their Biological Opinions (Step 3). This Biological Evaluation represents Steps 1 and 2 in the ESA pesticide consultation process for chlorpyrifos.

General Information

Chlorpyrifos is an insecticide used on a wide variety of terrestrial food and feed crops, terrestrial non-food crops, greenhouse food/non-food, and non-agricultural indoor and outdoor sites. There are currently 31 active registrants of chlorpyrifos with 135 active product labels (86 Section 3s, 48 Special Local Needs, and 1 Section 18), which include formulated products and technical grade chlorpyrifos (see **APPENDIX 1-2**). Currently, there are 13 multi-active ingredient products registered that contain chlorpyrifos (*i.e.*, products containing active ingredients in addition to chlorpyrifos). Chlorpyrifos can be applied in a liquid, granular, or encapsulated form or as a cattle ear tag or seed treatment. Aerial and ground application methods (including broadcast, soil incorporation, orchard airblast, and chemigation) are allowed. (See **APPENDIX 1-3** for details).

Chlorpyrifos enters the environment via direct application to use sites. It may move off-site via spray drift, volatilization (primarily following foliar applications), and runoff (generally by soil erosion rather than dissolution in runoff water). Major routes of chlorpyrifos transformation in the environment include alkaline hydrolysis, photolysis in air, and soil and aquatic metabolism (both aerobic and anaerobic). Chlorpyrifos is known to form chlorpyrifos-oxon, 3,5,6-trichloro-2-pyridinol (TCP), and 3,5,6-

trichloro-2-methoxypyridine (TMP). TCP and TMP are not considered residues of toxicological concern (see **APPENDIX 1-9**).

Chlorpyrifos is an organophosphate insecticide used to kill insects systemically and on contact. Organophosphate toxicity in animals is based on the inhibition of the enzyme acetylcholinesterase (AChE). Inhibition of AChE interferes with proper neurotransmission in cholinergic synapses and neuromuscular junctions which can lead to sublethal effects and mortality. The effects of chlorpyrifos have been studied extensively in many taxa, particularly in fish and aquatic and terrestrial invertebrates (see **Chapter 2**). The BE considered more than 1,400 ecotoxicity studies for chlorpyrifos (including ~180 fish studies, 26 amphibian studies, ~330 aquatic invertebrate studies, 32 aquatic plant studies, 58 bird studies, 1 reptile study, ~160 mammalian studies, ~500 terrestrial invertebrate studies, and ~125 terrestrial plant studies). Studies include acute and chronic laboratory and field studies with either technical or formulated chlorpyrifos, and include both registrant-submitted and open literature studies (search of relevant open literature data conducted up through May 2013). Toxicity to taxa from exposure to other chemical stressors of concern (*i.e.*, chlorpyrifos oxon, mixtures [*e.g.*, tank mixtures, formulated products, and environmental mixtures]) and non-chemical stressors (*e.g.*, temperature) are also considered.

Exposure Methods

Exposure values are based primarily on fate and transport model results. For aquatic exposures, the Pesticide in Water Calculator (PWC, v. 1.52, May, 2016)[a graphical user interface used to run Pesticide Root Zone Model (PRZM)/Variable Volume Water Body Model (VWWM)], AgDRIFT and AGricultural DISPersal (AGDISP) models are used to predict aquatic exposure in generic habitats, referred to as bins (see **Section 1.4.2.2.a.1.**). Aquatic exposure results for the bin(s) most appropriate for the species and/or critical habitat being assessed are used. For terrestrial exposures, existing models [*e.g.*, TerrPlant, AgDRIFT, AGDISP, earthworm fugacity model, Terrestrial Herpetofaunal Exposure Residue Program Simulation (T-HERPS), Terrestrial Residue Exposure model (T-REX) and portions of the Terrestrial Investigation Model (TIM)] were combined into a single tool that is referred to as the Terrestrial Effects Determination tool (TED)(see **Section 1.4.2.2.a.2.** and **ATTACHMENT 1-7**). A more detailed analysis using TIM and the Markov Chain Nest Productivity Model (MCnest) is also conducted for a subset of listed bird species. The models used in this BE can be found at [[HYPERLINK "https://www.epa.gov/endangered-species/provisional-models-endangered-species-pesticide-assessments"](https://www.epa.gov/endangered-species/provisional-models-endangered-species-pesticide-assessments)].

Overlap Analyses

Both the mosquito adulticide and wide area uses are presumed to overlap with all of the listed species ranges and critical habitats because they have no specific geographic footprint. Other use layers (as identified in **ATTACHMENTS 1-2** and **1-3**) that overlap with a large percentage of listed species ranges and critical habitats (*i.e.*, these use sites overlap with ~50 – 90% of the species and critical habitats, by number) include: right of way, developed and managed forests, open space developed, rangeland, pasture, other grains, golf courses, vegetables and ground fruit, other row crops, orchards and vineyards, wheat, and corn. The actual degree of overlap of specific uses with a particular species range varies widely and will be impacted by off-site transport distances (*e.g.*, spray drift and downstream transport).

Effects Determinations

To help determine the potential for risk, effects thresholds are established (see Interim agreement¹). For mortality to animals, the one-in-a-million chance of mortality [based either on the 5th percentile of the Species Sensitivity Distribution (SSD) or a surrogate LD₅₀, LC₅₀, or EC_x] is used to assess direct effects to a listed species (for details, see **ATTACHMENT 1-4**). For potential indirect effects based on prey lethality for those species without obligate relationships, the exposure that results in a 10% effect for the 5th percentile species on an SSD for the prey species or the 10% effect level for the most sensitive prey species tested (if not enough data are available for a SSD) is used. For sublethal effects, the direct effects threshold for animals and plants is the lowest available NOAEC/NOAEL or other scientifically defensible effect threshold (EC_x) that can be linked to survival or reproduction. For animals, the indirect effects threshold is the LOAEC/LOAEL for growth or reproduction for relevant taxa. For plants and indirect effects, the threshold is the lowest available LOAEC or EC₅₀ value (aquatic plants) and the lowest LOAEC or EC₂₅ value (terrestrial and wetland plants). These thresholds are used with other available data in a weight-of-evidence (WoE) approach which integrates the body of evidence that is available for making an effects determination. For the exposure assessment, the overlap of species range and action area, the relevance of predictive models to simulate EECs, the quality of fate data for exposure modeling and monitoring data that may be available are considered. For the effects analysis, the number of studies and/or species tested in the available toxicity data, taxonomic surrogacy, the magnitude and/or types of effects observed, and incident data are considered. An overall risk finding (high, medium, low) and a finding on the overall confidence (high, medium, low) in the available exposure and effects data is made for each line of evidence to inform the effect determinations for listed species and critical habitats (see **ATTACHMENT 1-9**).

Effects Determinations Summary

Because of the multitude of uses and use patterns for chlorpyrifos (including mosquito adulticide use), the action area for chlorpyrifos covers the entire US, including its territories. Therefore, all of the listed species ranges and critical habitats overlap with the action area and the “no effect” determinations largely involve species that are believed to be extinct (or extirpated from specific geographic areas) in USFWS documents and referenced in EPA species reports, but have not yet been delisted.

For chlorpyrifos, the results of the Step 1 (**‘No Effect’** (NE) or **‘May Affect’** determinations) and Step 2 (**‘Not Likely to Adversely Affect’** (NLAA) or **‘Likely to Adversely Affect’** (LAA) determinations) for species and designated critical habitats are presented in **Tables 1** and **2**, respectively. For species/critical habitats with a NE determination in Step 1, no additional analyses are conducted (they do not proceed to Step 2). For chlorpyrifos, all of the uses and use patterns modeled, result in threshold exceedances for most taxa. For species/critical habitats with NLAA determinations, they will be sent to the Services for concurrence. For species/critical habitats with a LAA determination, additional analyses will be conducted (*i.e.*, they proceed to Step 3).

¹ Interim approaches and agreement: [[HYPERLINK "https://www.epa.gov/endangered-species/interim-approaches-pesticide-endangered-species-act-assessments-based-nas-report"](https://www.epa.gov/endangered-species/interim-approaches-pesticide-endangered-species-act-assessments-based-nas-report)]

TABLE 1. Summary of Species Effects Determinations for Chlorpyrifos (Counts by Taxon).

TAXON	STEP 1 EFFECTS DETERMINATIONS		STEP 2 EFFECTS DETERMINATIONS		Totals
	NO EFFECT ¹	MAY EFFECT ²	NOT LIKELY TO ADVERSELY AFFECT ³	LIKELY TO ADVERSELY AFFECT ⁴	
Amphibians	0	40	1	39	40
Aquatic Invertebrates	0	220	1	219	220
Birds	5	103	12	91	108
Fish	0	193	5	188	193
Mammals	2	107	20	87	109
Plants	0	961	2	959	961
Reptiles	0	48	0	48	48
Terrestrial Invertebrates	9	147	0	147	156
Total	16	1819	41	1778	1835

¹ No further analysis is conducted for these species/critical habitats

² These species/critical habitats proceed to Step 2

³ These species/critical habitat determinations go to the Services for concurrence

⁴ These species/critical habitats proceed to Step 3

TABLE 2. Summary of Critical Habitat Effects Determinations for Chlorpyrifos (Counts by Taxon).

TAXON	STEP 1 EFFECTS DETERMINATIONS		STEP 2 EFFECTS DETERMINATIONS		Totals
	NO EFFECT ¹	MAY EFFECT ²	NOT LIKELY TO ADVERSELY AFFECT ³	LIKELY TO ADVERSELY AFFECT ⁴	
Amphibians	0	25	1	24	25
Aquatic Invertebrates	0	75	0	75	75
Birds	0	31	0	31	31
Fish	0	106	0	106	106
Mammals	0	32	4	28	32
Plants	0	462	3	459	462
Reptiles	0	17	4	13	17
Terrestrial Invertebrates	0	46	2	44	46
Total	0	794	14	780	794

¹ No further analysis is conducted for these species/critical habitats

² These species/critical habitats proceed to Step 2

³ These species/critical habitat determinations go to the Services for concurrence

⁴ These species/critical habitats proceed to Step 3